[*From the* Quarterly Journal *of the* Geological Society *for May* 1887.]

On Aristosuchus pusillus (*Owen*), *being* Further Notes *on the* Fossils *described by* Sir R. Owen *as* Poikilopleuron pusillus, *Owen*.

By H. G. Seeley, F.R.S., F.G.S., Professor of Geography in King's College, London.

[Plate XII.]

The Palæontographical Society in 1876 published a memoir upon a Wealden fossil, which Sir Richard Owen described as *Poikilopleuron pusillus*. These bones were then in the collection of the Rev. W. Darwin Fox, and, with the exception of the figured dorsal and caudal vertebræ, subsequently passed into the British Museum, with the Fox Collection. By the kindness of Dr. Henry Woodward, F.R.S., Keeper of the Geological Department, I have been able to examine these remains, and I would express my indebtedness for the facilities given me in making the study of which the results follow.

A question necessarily arises as to the grounds on which the animal is referred to the genus *Poikilopleuron* (recte *Pœcilopleurum*), because these are stated to be "the shape and texture of the vertebræ, and especially the latter." This statement implies that when a dorsal vertebra was divided vertically and longitudinally, it was found to have a medullary cavity, comparable to that seen in the vertebræ of *Poikilopleuron*. In the caudal vertebra the cavity is larger. Dr. Leidy, who has recorded a vertebra of the *Poikilopleuron*-type in the Cretaceous rocks of Colorado, remarks that an internal cavity of like character was only known to him in the caudal vertebræ of the Ox; but it is probably not rare among Dinosaurian reptiles. Mr. Hulke has shown that the character is also found in *Megalosaurus*, and other genera with hollow vertebræ have been described by Profs. Marsh and Cope. Whatever the value of this character may be, I submit that it is not generic, while there is no evidence which would associate any group of osteological characters with chambered vertebræ of this type.

Mr. Hulke has advanced some evidence to show that *Poikilopleuron* is *Megalosaurus*, and it will be admitted that the correspondence in form and character of the caudal vertebræ, and in the distal end of the tibia in these Oolitic Dinosaurs, if insufficient to establish absolute identity, at least proves a close affinity between them. And therefore the conclusion is legitimate that the resemblances found in the tail extend substantially to the sacrum, and that the same type of sacrum is found in *Poikilopleuron* as in *Megalosaurus*. When examining the validity of the genus *Poikilopleuron* Mr. Hulke did not discuss the sacrum, which constitutes the chief part of the evidence for the species *Poikilopleuron pusillus*.

If Sir Richard Owen is correct in his description of the sacrum of that fossil in referring only two vertebræ to the sacral region, and if the sacrum of *Megalosaurus* consists of five anchylosed vertebræ,

it is manifest, I submit, that the *Poikilopleuron pusillus* and *Megalosaurus Bucklandi* belong to two dissimilar genera. But the attempted affiliation of the Wealden fossil, now under discussion, to the genus *Poikilopleuron* does not establish the sacral characters of the genus *Poikilopleuron*, or furnish any ground for associating the genus with the Crocodilia. The charactors assigned to this fossil would rather go to show that it belongs to a genus which can have no near affinity to *Poikilopleuron*. In his Report on British Fossil Reptiles, Sir R. Owen fully described the characters of the sacrum of *Megalosaurus*, and he there points out that the neural arch is shifted in position, so that it overlaps the centrums of two contiguous vertebræ, as in the Ostrich and other birds and some Chelonians, so as to cause the perforation for the sacral nerve to be placed above the middle of the centrum, and that the sacral ribs are given off transversely at the junction of the bodies of the vertebræ. When the fossil named *Poikilopleuron pusillus* is examined, both these conditions of the Dinosaurian sacrum are found to be wanting. Each sacral centrum supports its own neural arch, the neural foramen has the same relative position as in other parts of the vertebral columu ; and the sacral ribs are given off from the bodies of the vertebræ, and not from the suture between them. It is therefore evident that the fossil is far removed from *Megalosaurus*, and inferentially from *Poikilopleuron*. As it differs in fundamental characters from known Dinosaurs, while there are strong reasons for believing it to be Dinosaurian, I regard it as the type of a new genus, *Aristosuchus*.

Sir R. Owen has figured some bones which were associated with this sacrum (see Pl. XII. fig. 14). There is a median symmetrical bone, to which are attached portions of a pair of rib-like bones, on which the author observes, "the nearest guess I can make as to their nature is that they represent part of the series of abdominal ribs with their sternum." These remains I regard as the pubes.

An ungual phalanx is figured on the same plate, and briefly described as being "of the rapacious type." This fossil I think should probably be rejected, as not being a portion of the same animal, for it shows all the characters of a claw-phalange from the fore limb of an Ornithosaur, though it may be observed that in *Lælaps* the claw-phalanges are as much compressed from side to side. With these differences in the interpretation of the remains a new description of their characters becomes a necessity.

I will first examine the pubic bones and assume, as Sir R. Owen has done, that these bones are in natural association with the sacrum, with which they are still closely connected by matrix, though they are displaced and are twisted round, so that the anterior border is directed posteriorly.

The pubic bone is imperfect proximally, and the expanded portion which united with the ischium and ilium is lost. The parts preserved are the anteriorly directed, distally extended, rod-like parts of the pubes, which converge towards their distal extremities, where they merge in a horizontal posterior extension capable of assisting.

in the support of the weight of the body when at rest. This type of pubis, which Professor Marsh has described in *Allosaurus* and *Cœlurus*, has not hitherto been detected in this country, but may be present in the Wealden rocks in other species; for while studying this specimen, Dr. Henry Woodward submitted to me the pubis, imperfect distally, of a type very similar to *Cœlurus*, from Tilgate. This corroboration is the more interesting as the Sussex type of animal shows the proximal end of the bone.

The pubes are somewhat crushed together (fig. 14, *p*); I accordingly drew the anterior aspect of one of the bones in its natural position, and repeated it, reversed, on the opposite side, so as to reproduce the form which the pubic bones show when seen from the front (see woodcut below), with the result that a close general resemblance was established to the pubis which Marsh has referred to *Cœlurus*; and without attaching too much taxonomic importance to this fact, it establishes the interest of the fossil, in being a European representative of an American type.

Anterior aspect of pubic bones of *Aristosuchus* restored. ½ nat. size.

a. Unossified extremity of the ventral keel.

The part of the pubic bone preserved in this specimen extends distally for 13 centimetres. Where the bones converge distally they unite at an angle of about 60° with the posterior extension,

which extends like the metal of an adze from the haft. Where the bones are fractured proximally they are compressed from side to side, and extend upward with a slight sigmoid curve inward, which is completed distally by the convergence of the bones. At the proximal fracture the bone measures 12 millimetres in the antero-posterior direction, and 6 millimetres from within outward, with the borders rounded in front and behind, but a linear muscular furrow ascends the inner posterior border of the bone. As the bone expands a little in antero-posterior extent as it extends proximally it curves a little forward, making the anterior border of the proximal end of the bone slightly concave, and the posterior border very slightly convex. All the middle portion of the bone preserves about the same antero-posterior measurement of 8 millimetres; but distally the measurement increases by an expansion which is chiefly behind the median axis of the bone, till at its line of junction with the posterior distal expansion its width is 2·5 centimetres.

The middle of the shaft is well-rounded externally, but as the bone widens distally this external surface begins to be flattened till it merges in the flat distal posterior expansion. But the middle of the shaft is compressed from front to back, so as to form a sharp internal edge, and here the measurement from within outward is 13 millimetres. This sharp internal ridge is 6 centimetres long and parallel to the external outline. In this region of the bone the anterior face is convex from within outward, while in length there is a very slight convexity. The posterior aspect is flattened.

Distally for a length of fully 3 centimetres the bone is compressed from within outward. Anteriorly something of the distal termination may be lost, but the mass preserved extends posteriorly for 9·3 centimetres, with a perfectly straight flat base, which is 1·5 centimetres wide in front, and narrows posteriorly to a few millimetres. A median groove deepening in front extends along the anterior end of the base for 3·5 centimetres. The lateral surfaces of this posterior keel are slightly concave; they converge upward to a sharp keel, which has a gently convex contour, as it tapers posteriorly to a blunt point; its depth near the shaft is 2 centimetres.

Both the pubic bones are slightly displaced distally, where they unite with this keel, and these junctions, which are not quite symmetrical, have been regarded by Sir R. Owen as sutures. The point is difficult. The anterior extremity of the bone was certainly cartilaginous, and the anterior extremities of the pubes are exposed, distinct from each other, and distinct from the keel; but this is hardly conclusive evidence of separate ossification, which is not improbable. Proximally a small fragment of a thinner bone is seen, posterior in position, which may have belonged to the ischium.

The only animals with which this form of pubis can be compared have been described by Prof. Marsh as *Cœlurus*, with which genus Prof. Marsh identifies the specimen now described*. So far as I can judge from the figures given by Marsh, it is simply proved to be closely related to *Allosaurus*, *Cœlurus*, and *Ceratosaurus*, and

* American Journal of Science, vol. xxvii. p. 335 (April 1884).

though I may think the resemblance strongest with *Cœlurus* and *Allosaurus*, it may be equally strong with *Ceratosaurus*. But when Prof. Marsh refers pelvic structures so similar as the pubes of *Allosaurus* and *Ceratosaurus* to distinct suborders of the Dinosauria, I can only conclude, if these references are correctly made and sustained, that the pubis is not always a bone on which a generic identification can be based, especially when it is imperfect proximally. I should not thus have ventured to question Prof. Marsh's reference of this pubis to a genus of his own creation were it not that there is what I regard as strong ground for believing that the sacrum associated with the pubis, no less than the dorsal vertebra figured by Sir R. Owen, belong to a genus which can be but distantly related to *Cœlurus*.

Sir R. Owen, in representing the vertical section of the dorsal vertebra, shows that the centrum is formed of the same kind of tissue, and ossified in the same way as the vertebræ of Dinosaurs in general, except that a fusiform longitudinal space is enclosed which gives no indication of being pneumatic, and appears to open into the neural canal. Now, in *Cœlurus*, Prof. Marsh has defined a genus which, in the construction of its axial skeleton, can only be compared to Ornithosaurs, having the bones invested with a thin film of bone-tissue of uniform thickness and distinctive peculiar texture. This character is as well demonstrated in Marsh's section of a dorsal vertebra as in the cervical region. Therefore the dorsal vertebræ of *Aristosuchus* cannot be referred to *Cœlurus*. Moreover the mode of attachment of the ribs is dissimilar. And hence I submit, as the sacrum of *Cœlurus* is unknown, there is no reason to suppose that it would be at all like the sacrum of *Aristosuchus*, which I now describe.

There are five vertebræ in the sacrum completely anchylosed together by their neural arches (fig. 13), and either anchylosed or in process of anchylosis by their centrums. Sir R. Owen regards the two posterior vertebræ as sacral, and the three anterior vertebræ as lumbar. Here the difference of interpretation must be adjusted by the definition of the sacrum which is adopted. If the sacral vertebræ are those from which strong sacral ribs are given off for support of the ilium, then no doubt only two such vertebræ can be counted, and the other three vertebræ in which the ilium is more or less supported on transverse processes given off from the neural arch may be termed sacro-lumbar vertebræ. This, however, involves theoretical considerations which cannot be demonstrated, for it is impossible to say how many sacral nerves united into a sacral plexus. And as all the transverse processes have the same transverse development (fig. 13, *t*), and the anchylosis of the vertebræ shows that they took part in supporting the body, I adhere to the old nomenclature, and regard all the vertebræ which supported the ilium as sacral. I believe the anterior vertebræ also contributed to support the pelvic bones, though their share in the work was less than that of the last two.

There is a fundamental difference in the plan of structure of the

sacrum and that of most other British Wealden reptiles; for while the transverse processes or sacral ribs in *Iguanodon*, *Hylæosaurus*, *Megalosaurus*, &c. are given off at the junction of the centrums, the transverse processes are here, as Sir R. Owen's figure shows, given off from the individual vertebræ to which they belong (fig. 14), as in the American genera described by Marsh, such as *Morosaurus*, *Apatosaurus*, *Atlantosaurus*, *Stegosaurus*, *Brontosaurus*, &c., and as in *Omosaurus*.

The five sacral vertebræ measure 12 centimetres. The first two (fig. 14, 1, 2) are very slightly longer than the succeeding three. The bodies of the vertebræ are constricted from side to side, so that though the flat transversely ovate articular face of the first vertebra measures 2·2 centimetres wide by 1·8 centimetre deep, the transverse measurement through the middle of the centrum is only 7 or 8 millimetres. The form of the centrum is thus almost Teleosaurian in its constriction. The second centrum has a slight tendency to be flattened on the ventral side, which is less marked in the third, while the fourth appears to carry a slight median ridge. The parallel ligamentous striations seen on the anterior border of the first vertebra are necessarily absent from the suberenulate junctions of the succeeding vertebræ.

The neural spine is very thin and is broken away in every specimen (fig. 13, *ns*), so that the greatest height from the base of the centrum, as preserved, is only 3·5 centimetres. The third and fourth vertebræ develop additional lateral spines, one on each side of the median vertical neural spine, and these spinous processes directed outward and upward, termed metapophyses (fig. 13, *m*), correspond to those seen in the lumbar and caudal vertebræ of many mammals and the sacrum of *Megalosaurus*. Metapophyses are indicated on the second vertebra by long blunt ridges, and on the fifth vertebra by short ridges which are almost tubercles.

The transverse process from the first sacral vertebra (fig. 14, 1) is given off from the sides of the neural arch, and is directed obliquely upward and backward, terminating outward in a narrow vertically compressed process of a wedge shape, constricted in the middle, flattened behind, sharp in front, concave below, and convex above, with a strong tubercle in the middle of the upper surface.

The transverse measurement between the extremities of the processes is 33 millimetres. The antero-posterior extension of the process along its outer border is 12 millimetres, and the corresponding measurement at the middle of the constriction of its sides is 7 millimetres.

The transverse process of the second vertebra is in the anterior half of the vertebra, has a strong base posteriorly, and forms a vertically elongated, somewhat flattened, articulated surface, which is 1·9 centimetre deep in front, where the vertical border is concave, and 1·1 centimetre deep behind, so that the upper and lower surfaces converge posteriorly (fig. 14, 2). Its antero-posterior extent is 1 centimetre. The articular surface is irregular in contour, well defined, and does not extend to quite the same upward elevation as

the first process. Its upper aspect is angular, with an oblique ridge extending outward and forward to its superior angle.

The transverse process of the third vertebra is on a level with the neural canal and has a strong base. It is 12 or 13 millimetres long, is in the middle of the length of the vertebra, and forms a vertically compressed lamina (fig. 14, 3). It is slightly convex below and flattened above, with a sharp ridge on its anterior margin, which extends obliquely inward and backward, and ascends the side of the metapophysis, inclined obliquely backward.

In the fourth vertebra the transverse process is much stronger. It arises from the anterior half of the centrum, and like the process from the preceding vertebra is partly on the centrum and partly on the neural arch. It is elongated in the antero-posterior direction, subreniform on the articular facet, which is expanded, and flattened and convex below, 17 millimetres long, about 8 millimetres deep behind, and less in front (fig. 14, 4). A strong transverse ridge on the hinder part of the upper surface defines an anterior concave area, and ascends the middle of the metapophysis. The transverse measurement between the facets for the ilia, as in the previous vertebra, is about 3 centimetres.

The process on the fifth vertebra is of about the same length. Its antero-posterior extent, 17 millimetres, is slightly greater, but it is less deep. It is flattened on the underside. The outline of the facet for the ilium is subtriangular, owing to the very strong development of the ridge on its upper surface. This ridge extends obliquely forward so as to define an anterior concave cup-like depression, and a posterior oblique area on which is a tubercle which represents the metapophysis. On this vertebra the facets of the postzygapophyses are developed (fig. 14, *pz*). The transverse measurement over them is 12 millimetres; they are divided posteriorly by a deep vertical furrow which ascends the neural spine so far as it is preserved. They have the usual ovate form, and look obliquely downward and outward. Only the margin of the posterior surface of the centrum is exposed.

The outlets for the sacral nerves are through round foramina, situate between the centrum and the neural arch, at the junction of two vertebræ (fig. 14, *f*). They are seen on the left side in the second vertebra, and on the right side in the third and fifth.

The half of the dorsal vertebra preserved has the centrum 2 centimetres long at the base and 2·2 centimetres long on the neural canal, and this indicates that the back was arched. The articular ends of the centrum are very slightly concave, with a ligamentous marking at the external border. The middle of the centrum is constricted and rounded at the base. The transverse process is thin and given off above the neural canal. From the neural platform an anterior ridge descends almost vertically, and another ridge descends obliquely behind it. The height of the platform from the base of the centrum is 2·3 centimetres. The height of the centrum is 1·4 centimetre.

Only a fragment of a caudal vertebra is preserved. It is similar in form to that figured by Sir R. Owen, and similar to that attri-

buted by Marsh to *Cœlurus*, and is similarly hollow. What is the evidence of its association with the other remains cannot now be determined. The bone has a well-marked basal canal, defined at its extremity by the relatively large confluent facets for the chevron bones, which, subtracting from the quadrate end of the bone, convert it into a transversely ovate articulation.

I conclude that this animal is distinct from every British Dinosaur, but that it is nearly related to some imperfectly known types, described by Prof. Marsh, like *Allosaurus*. But what the nature of that relation may be must remain undetermined until more is known of the American Dinosauria.

EXPLANATION OF FIGURES.

Plate XII.

(The figures are of the natural size.)

Fig. 13. Neural aspect of sacrum of *Aristosuchus*, showing the transverse processes, metapophyses, and neural spines: *ns*, neural spine; *m*, metapophyses; *t*, *t*, transverse processes; *pz*, postzygapophysis.

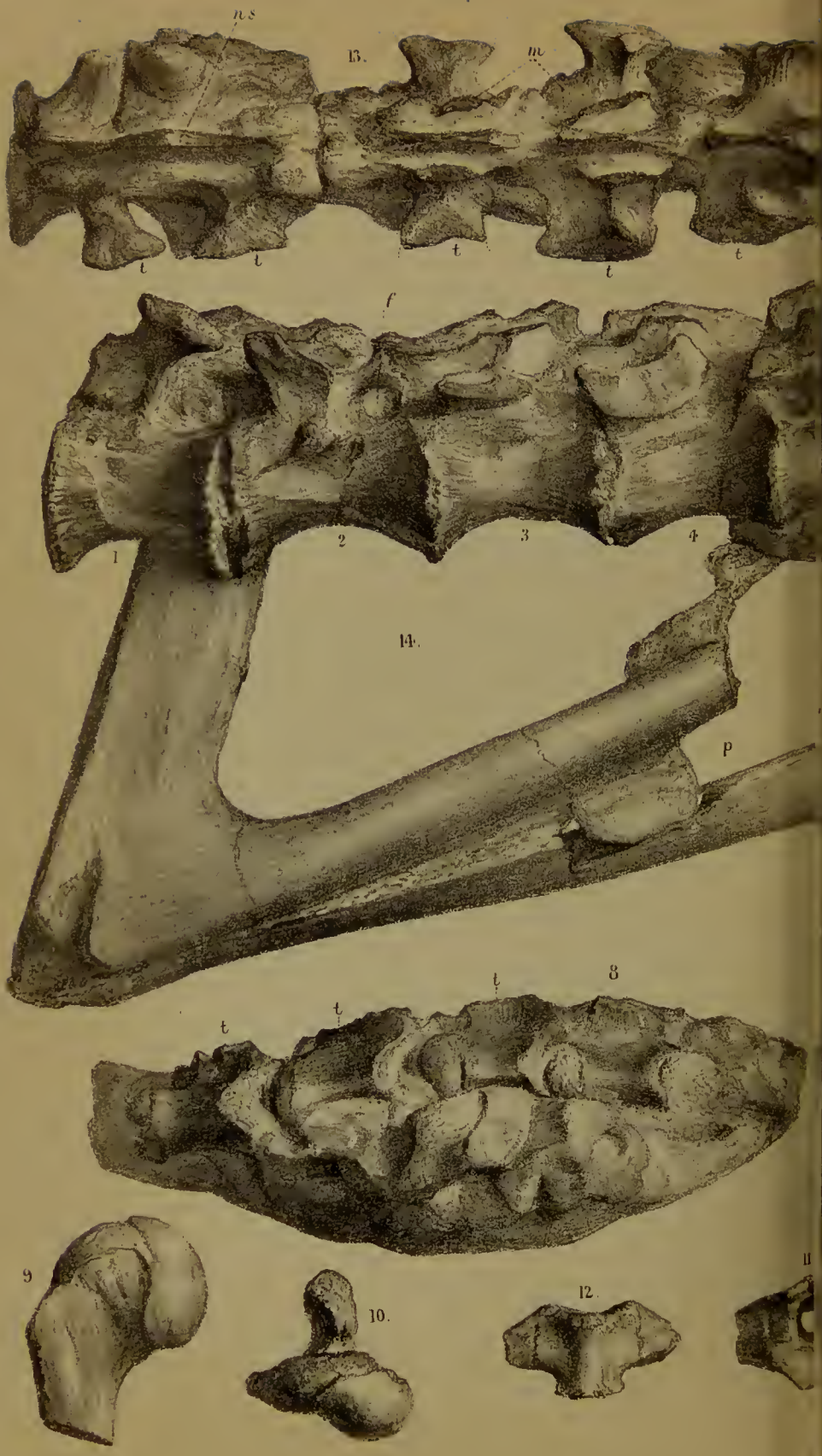
14. Lateral view of sacrum and pubes, showing their association: *f*, foramen of sacral nerve; *p*, pubic bones; *pz*, postzygapophysis.

Discussion.

The President said that valuable work was being done by Prof. Seeley in reexamining forms long since described, and comparing them with the more recent American discoveries.

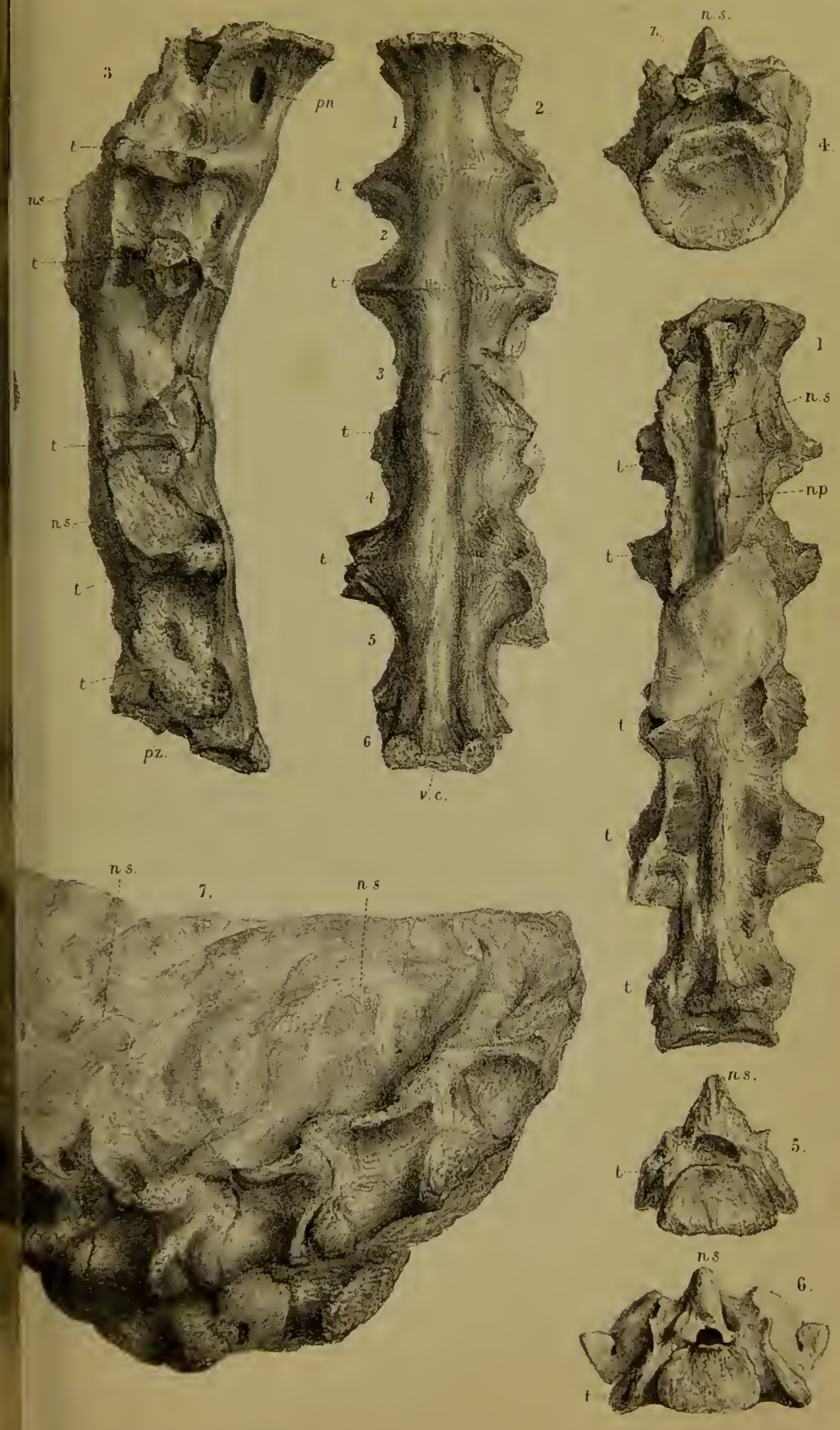
Mr. Hulke had known the specimen for a long time, even before it was described by Prof. Owen. He quite agreed that the specimen had nothing to do with *Poikilopleuron*. He thought the three anterior vertebræ were different from the two posterior, and doubted if the first three were sacral. The first transverse process appeared to him longer than the others. The question as to whether the remains were Crocodilian or Dinosaurian was intimately connected with this identification of the vertebræ. There was also a question as to whether the bones referred by Prof. Seeley to the pubis had the form of symphysial union assigned to them. He preferred suspending his judgment for the present.

Prof. Seeley, in reply, said he thought if the specimen had been before the Society there would not appear to be much difference between his views and Mr. Hulke's. He showed that the last vertebra preserved was the posterior sacral vertebra because the postzygapophyses were preserved, whilst the first three of the five had approximately the same transverse measurement as the last two. No doubt the transverse processes differ, but this is the case in other Dinosaurs. It was quite possible that the pubic bones had the keel separately ossified; but he thought there could be no doubt as to the osteological identification.



F H Michael del et lith.

ORNITHODESMUS, HETEROSU



CAURUS AND ARISTOSUCHUS.

Mintern Bros. imp

SOME
IMAGES/IMAGE
TEXT FALL INTO
GUTTERS